US 20190101366A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2019/0101366 A1**

(43) **Pub. Date: Apr. 4, 2019**

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(54) **ANTI-DRONE WEAPON**

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(21) Appl. No.: **16/150,942**

(22) Filed: **Oct. 3, 2018**

Related U.S. Application Data

(60) Provisional application No. 62/567,713, filed on Oct. 3, 2017.

Publication Classification

(51) **Int. Cl.**

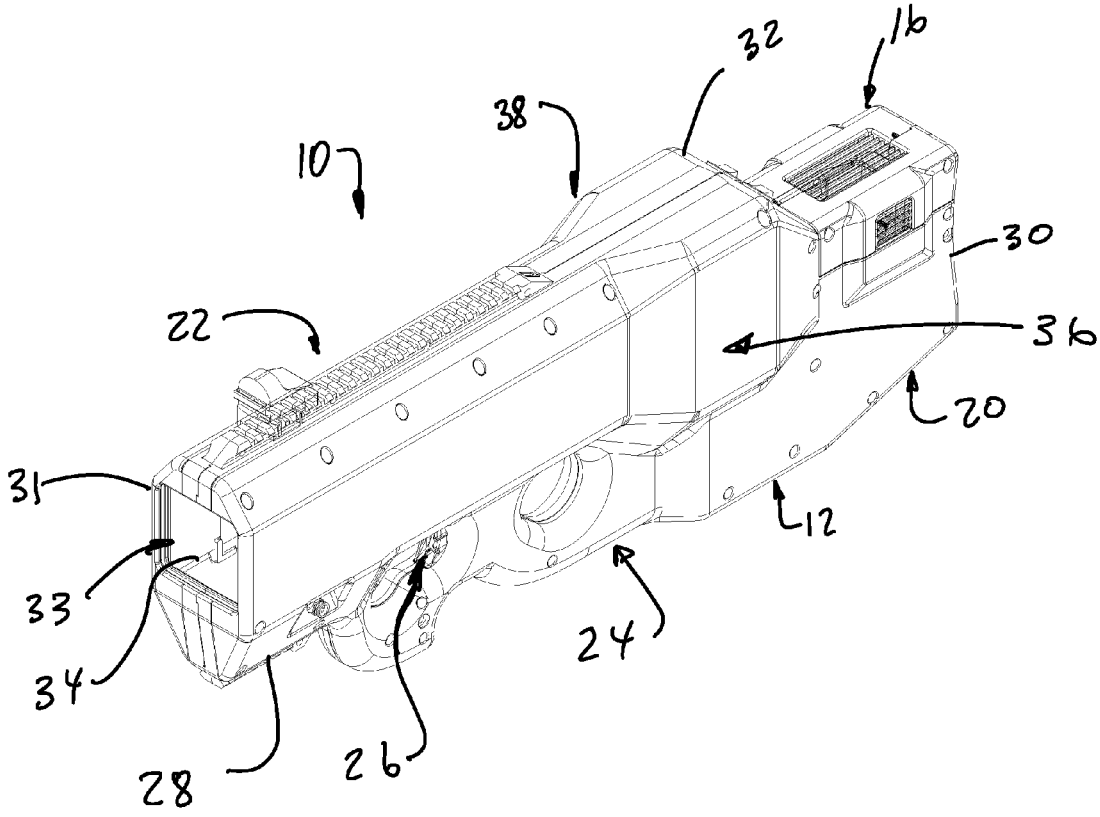
F41H 13/00	(2006.01)
H04K 3/00	(2006.01)

(52) **U.S. Cl.**

CPC ***F41H 13/0075*** (2013.01); *G01S 19/39* (2013.01); ***H04K 3/224*** (2013.01); ***H04K 3/90*** (2013.01)

(57) **ABSTRACT**

An anti-drone weapon having a housing and at least one antenna positioned within the housing. The at least one antenna capable of operating at a frequency at least between 400 MHz and 6 GHz. In some configurations, a power supply, processor and control circuitry and a control panel, within the housing. In some configurations, the at least one antenna includes three antenna, including, a double helical antenna, a quasi-yagi antenna and a log-periodic antenna.



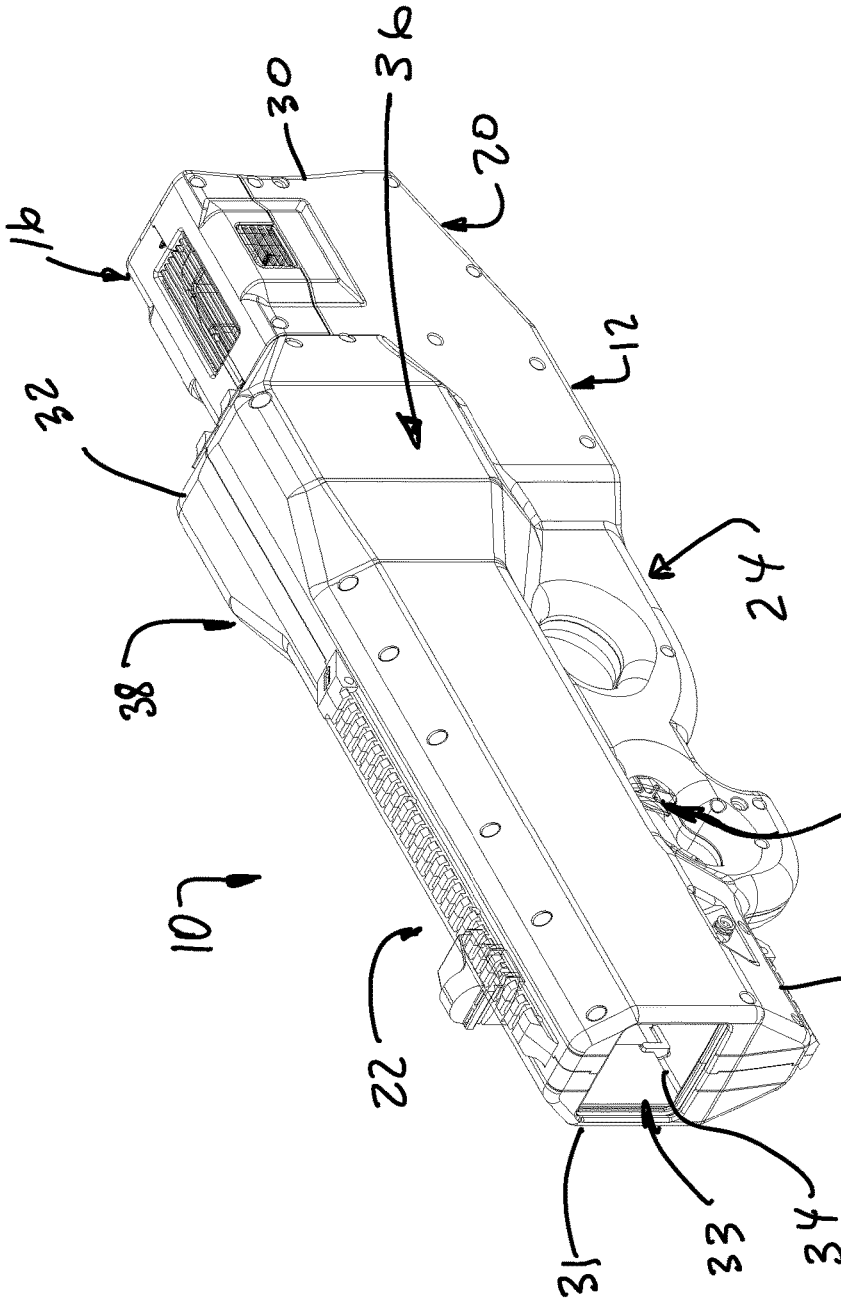


FIGURE 1

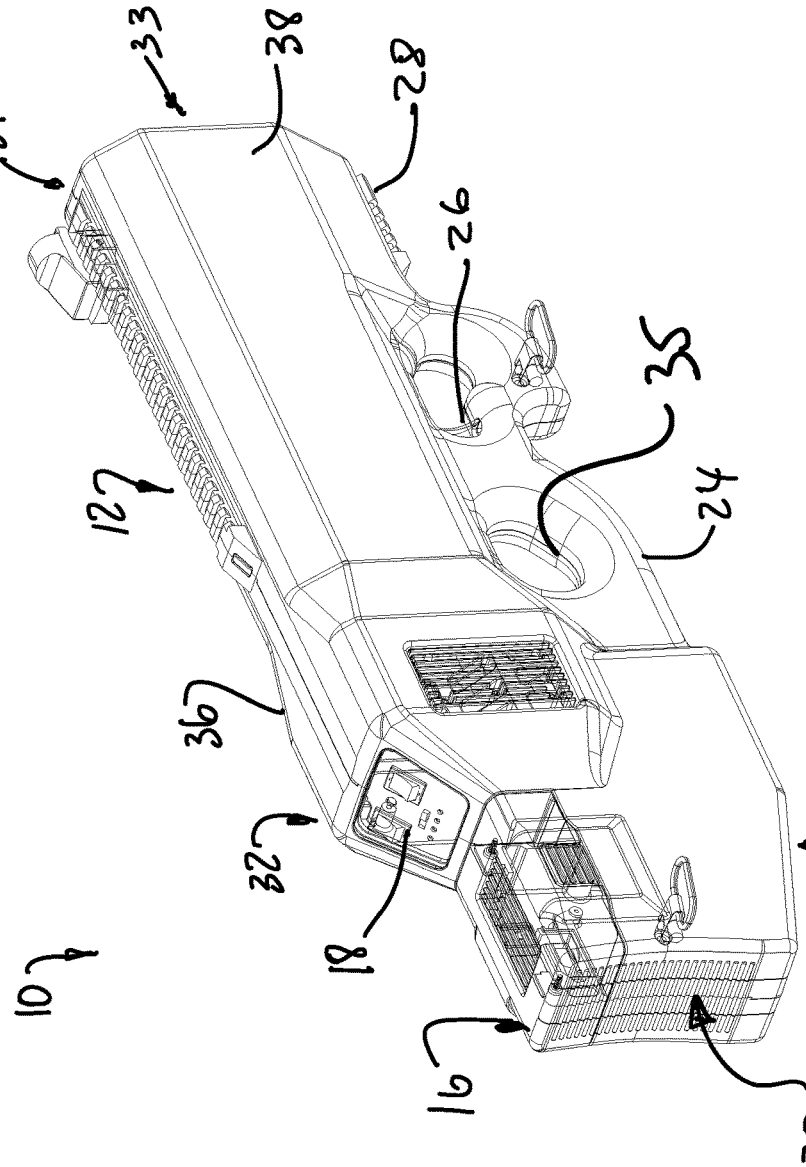


FIGURE 2

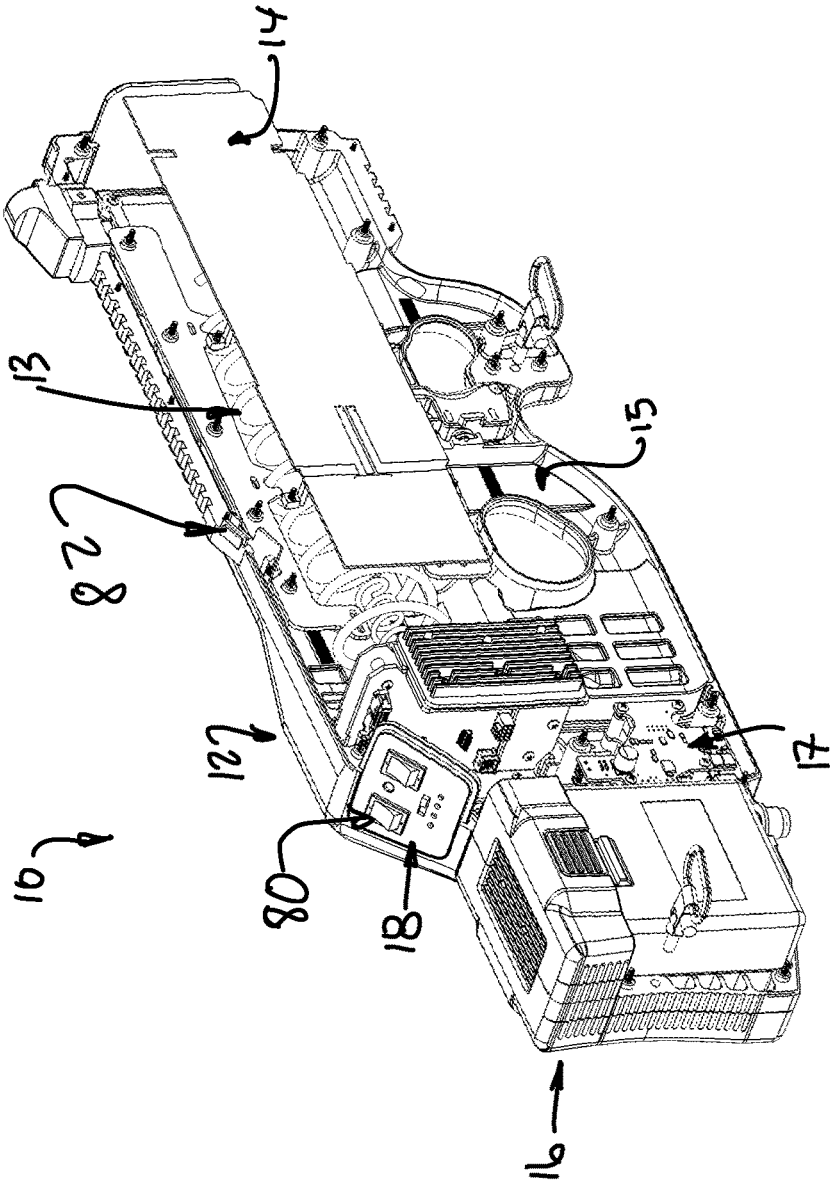


FIGURE 3

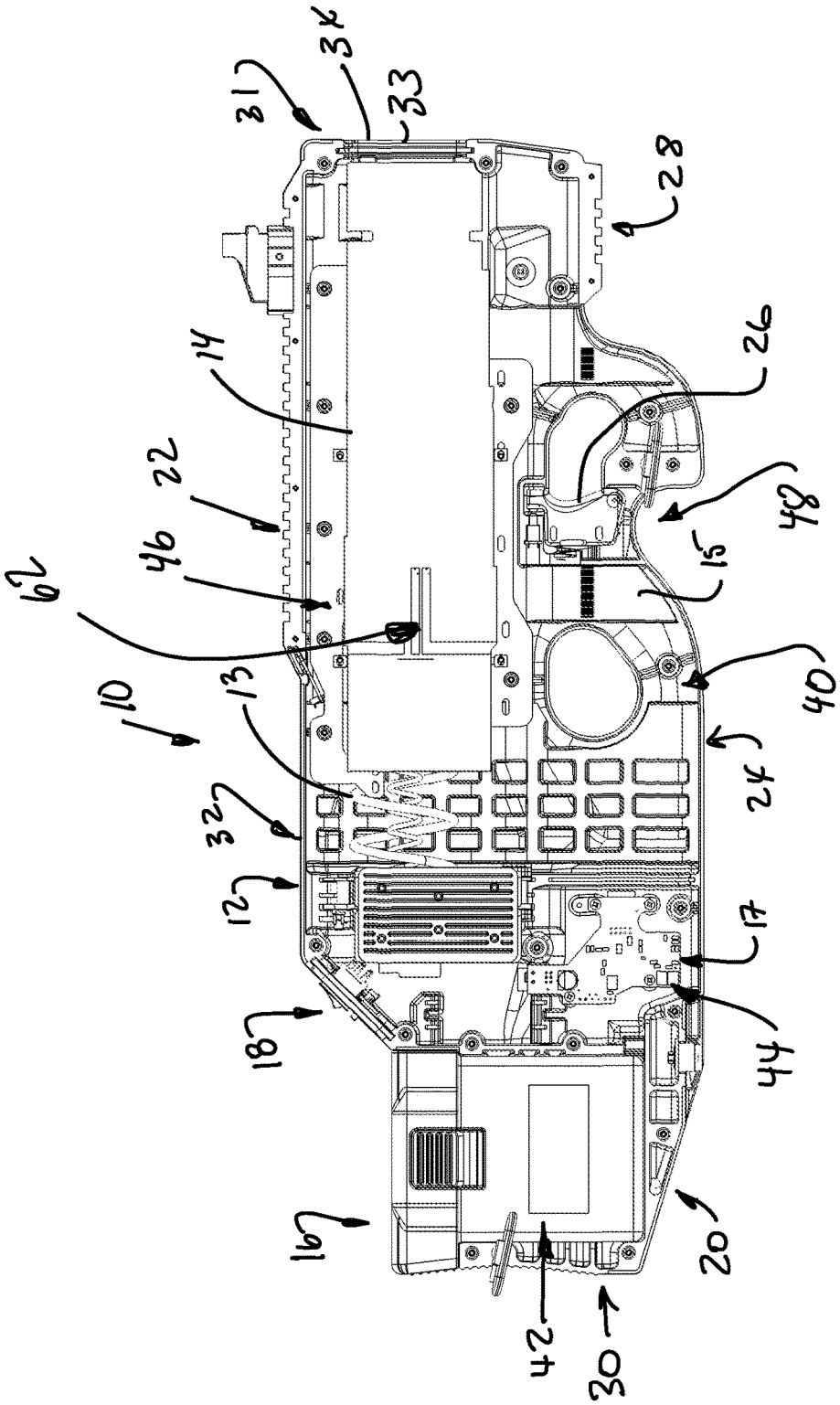


Figure 4

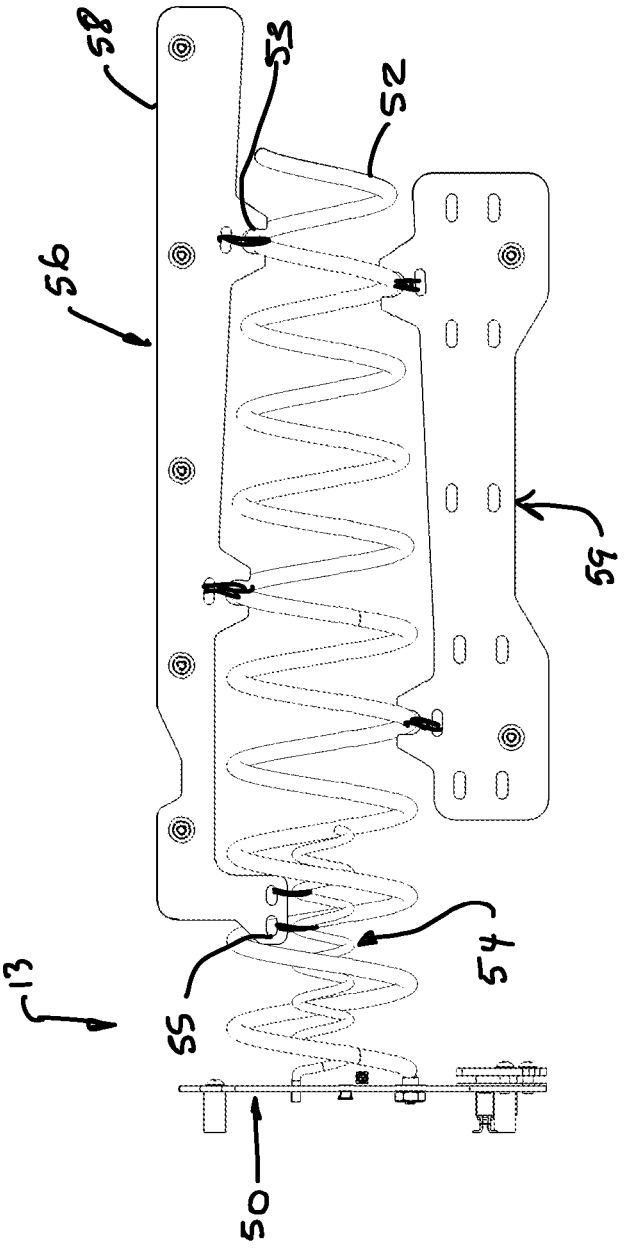


FIGURE 5

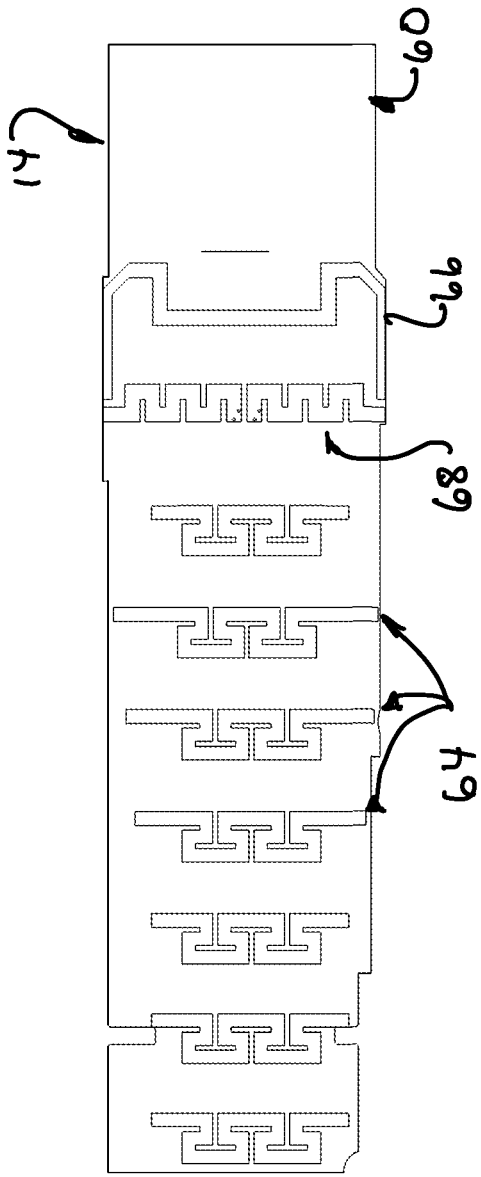


FIGURE 6

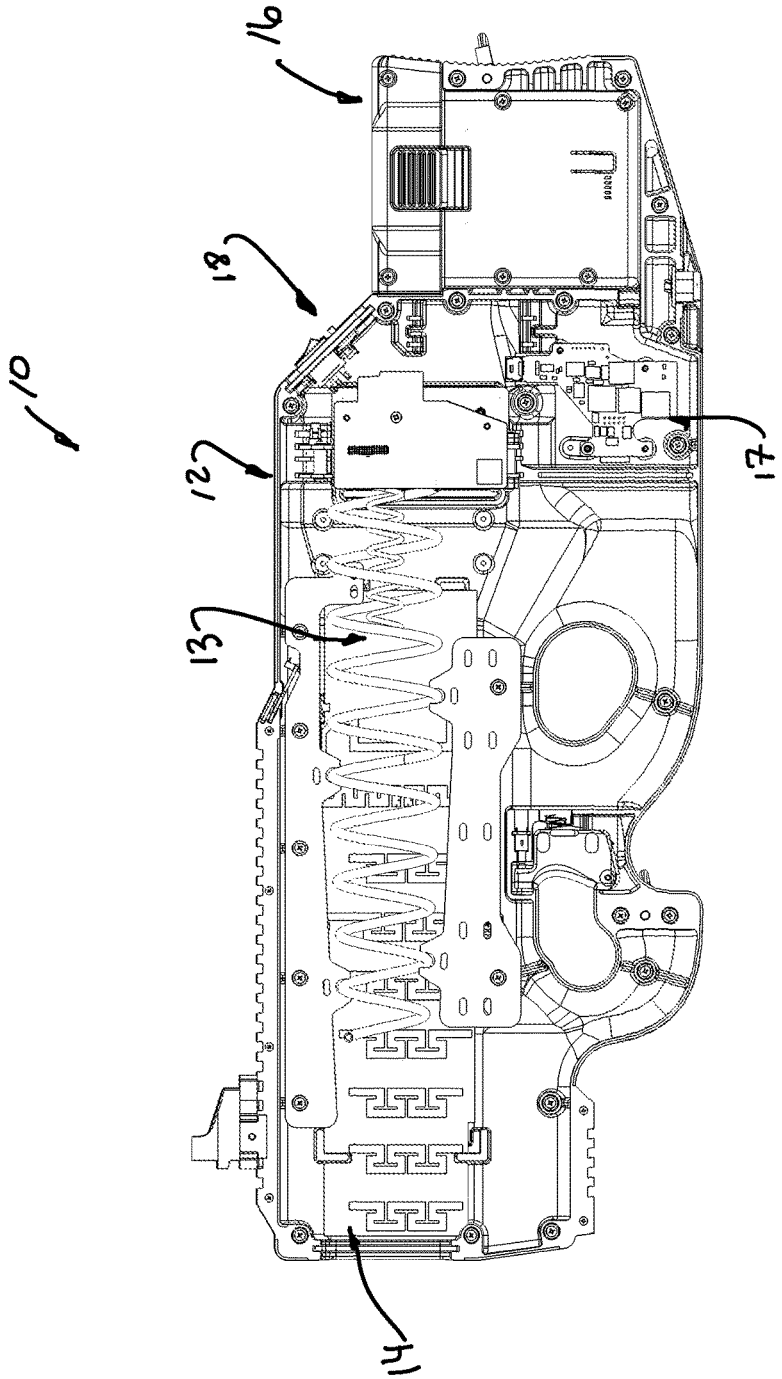


Figure 7

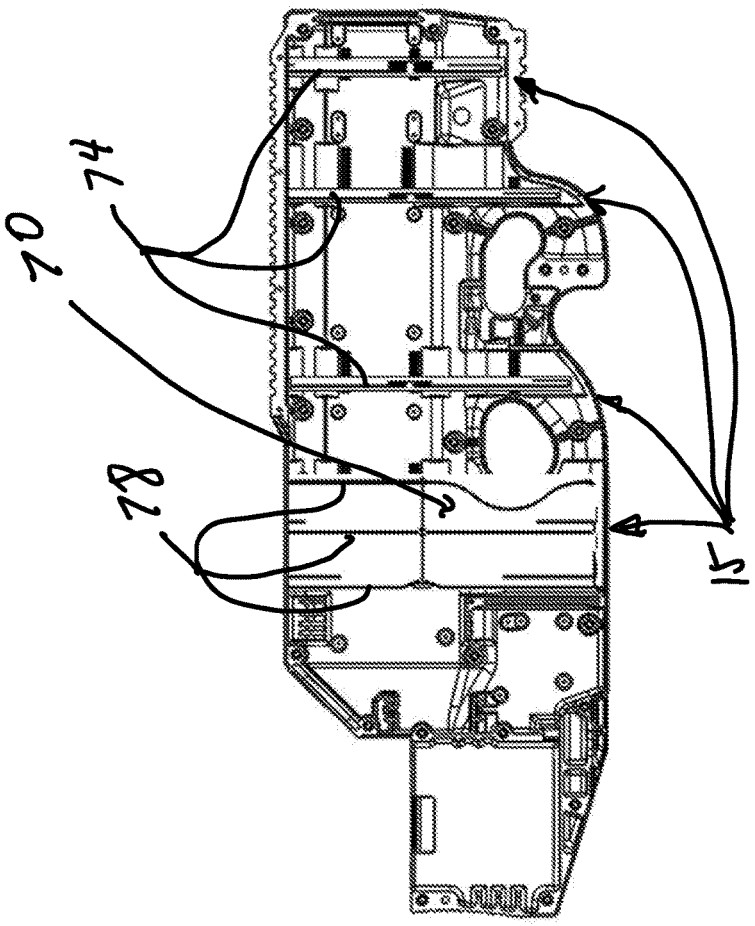


Figure 8

ANTI-DRONE WEAPON

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority from U.S. Pat. App. Ser. No. 62/567,713 filed Oct. 3, 2017, entitled "Anti-Drone Weapon", the entire disclosure of which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE DISCLOSURE

1. Field of the Disclosure

[0002] The disclosure relates in general to weapons, and more particularly, to an anti-drone weapon that can receive and transmit signals to detect and disrupt the operation of remotely piloted radio-controlled vehicles as well as autonomous vehicles navigating with Global Navigation Satellite Systems (GNSS) such as GPS. The device is not limited to countering Unmanned Air Systems (UASs), e.g., "drones", however, the device is particularly well-suited to disable, disrupt and/or destroy aerial targets.

2. Background Art

[0003] Increasingly, terrorist groups, foreign militaries, criminal organizations, and other groups are utilizing drones and other unmanned vehicular systems for airspace control, surveillance, and ground attack missions. Drones are readily weaponized with remotely deployed and/or detonated grenades, claymores, mortar shells, and Improvised Explosive Devices (IEDs) and have proven effective at inflicting casualties and slowing the advance of state troops, allied warfighters, and security personnel, especially in urban settings.

[0004] Problematically, most drones are small and nimble, making them hard targets for firearm-based countermeasures and other conventional kinetic assets. They are also capable of maneuvering at high altitude, reducing detection and increasing survivability. Moreover, due to their high speed and maneuverability, it is often difficult to effectively engage drones. Hundreds to thousands of rounds are typically fired to remove a single drone threat in a combat theater.

[0005] In lieu of physically hitting the drone with kinetic projectiles or airburst shrapnel, some counter-drone systems disrupt the communication between the drone and its controller (usually a remotely positioned pilot), disrupt the operation of the drone's navigation system, and/or disrupt its inertial or optical navigation and stability sensors. Such disruptions can be sufficient to cause a drone to abandon its mission, or to land, crash, or stop its movement to simplify kinetic or other conventional engagement techniques.

[0006] While other counter-drone disruption systems have been developed and released as products, there remains a need to have a highly portable and lower-power unit that can effectively disrupt communication and operation of drones and other unmanned threats.

SUMMARY OF THE DISCLOSURE

[0007] The disclosure is directed to an anti-drone weapon. The anti-drone weapon having a housing and at least one antenna positioned within the housing. The at least one antenna capable of operating at a frequency at least between 400 MHz and 6 GHz. In some configurations, a power supply, processor and control circuitry and a control panel, within the housing. In some configurations, the at least one antenna includes three antenna, including, a double helical antenna, a quasi-yagi antenna and a directed log-periodic antenna.

[0008] It is contemplated that the anti-drone weapon be fully self-contained, and have a weight that is less than 6 kg, and more preferably less than 3.6 kg.

[0009] It is contemplated that the weapon work throughout the following frequencies and frequency regions: GNSS (including GPS, GLONASS, Galileo, and BeiDou) L1, GNSS L2, 2.4 to 2.5 GHz and 5.6 to 6.0 GHz, 1250 to 1290 MHz, 870 to 928 MHz, and 420 to 460 MHz.

[0010] It is contemplated that the weapon has an effective operational range of approximately 500 to 1,000 meters to address potential threats at a tactically advantageous stand-off distance. It is further contemplated that the device is able to recognize and sense drones in a range up to and including 3.2 kilometers in distance.

[0011] In some configurations, the housing further includes a stock and a barrel extending therefrom. The barrel includes a proximal end and a distal end.

[0012] In some configurations, a power supply, processor and control circuitry is maintained in one of the stock and the barrel.

[0013] In some configurations, the barrel defines a cavity, having a double helical antenna positioned with a base at the proximal end, and extending toward the distal end.

[0014] In some configurations, the double helical antenna is coupled to the barrel between the proximal and distal end through at least one of an upper mounting bracket and a lower mounting bracket.

[0015] In some configurations, the upper mounting bracket and the lower mounting bracket comprise a polymer, which is releasably coupled to at least one helix of the double helical antenna.

[0016] In some configurations, the anti-drone weapon further comprises a second antenna assembly positioned to a first side of the double helical antenna and extending between the proximal and the distal end.

[0017] In some configurations, the second antenna comprises a quasi-yagi antenna.

[0018] In some configurations, the second antenna is substantially planar.

[0019] In some configurations, the anti-drone weapon further comprises a third antenna assembly positioned to a second side of the double helical antenna.

[0020] In some configurations, the third antenna comprises a directed log-periodic antenna.

[0021] In some configurations, the third antenna is in a non-planar configuration.

[0022] In some configurations, the housing further includes a trigger and a thumbhole for the grip. A portion of the third antenna extends between the trigger and the thumbhole for the grip.

[0023] In some configurations, the first antenna operates on ranges that include GNSS (including GPS, GLONASS, Galileo, and BeiDou) L1, GNSS L2, 1250 to 1290 MHz, 2.4 to 2.5 GHz, and 5.6 to 6 GHz frequencies, the second antenna generally operates at 870 to 928 MHz frequencies and the third antenna generally operates between 420 to 460 MHz frequencies.

[0024] In some configurations, the anti-drone weapon weighs approximately 6 kilograms or less.

[0025] In some configurations, the anti-drone weapon has a range of approximately 1000 meters.

[0026] In some configurations, the housing is formed from a port case half and a starboard case half.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The disclosure will now be described with reference to the drawings wherein:

[0028] FIG. **1** of the drawings is a perspective view of the anti-drone weapon from the front end thereof;

[0029] FIG. **2** of the drawings is a perspective view of the anti-drone weapon as from the back end thereof;

[0030] FIG. **3** of the drawings is a perspective view of the anti-drone weapon showing, in particular, having the starboard side housing removed;

[0031] FIG. **4** of the drawings is a side elevational view of the anti-drone weapon as shown in FIG. **3**;

[0032] FIG. **5** of the drawings is a side-view of the helical antenna assembly;

[0033] FIG. **6** of the drawings is a side-view of the second antenna assembly;

[0034] FIG. **7** of the drawings is a side elevational view of the anti-drone weapon having the port side housing portion removed; and

[0035] FIG. **8** of the drawings is a side-view of the third antenna assembly.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0036] While this disclosure is susceptible of embodiment in many different forms, there is shown in the drawings and described herein in detail a specific embodiment(s) with the understanding that the present disclosure is to be considered as an exemplification and is not intended to be limited to the embodiment(s) illustrated.

[0037] It will be understood that like or analogous elements and/or components, referred to herein, may be identified throughout the drawings by like reference characters. In addition, it will be understood that the drawings are merely schematic representations of the invention, and some of the components may have been distorted from actual scale for purposes of pictorial clarity.

[0038] Referring now to the drawings and in particular to FIGS. **1** and **3**, the anti-drone weapon is shown generally at **10** and comprises housing **12**, helical antenna assembly **13**, second antenna assembly **14**, third antenna assembly **15**, power supply **16**, processor and control circuitry **17**, and control panel assembly **18**. It is to be understood the antenna systems, power supply, and relevant circuitry are all substantially encased and protected by the housing. Further, the antenna systems all extend within the housing in such a way the independent assemblies are generally positioned proximate to one another.

[0039] The housing assembly **12**, show in detail in FIGS. **1**, **2**, and **4**, comprises a stock **20**, barrel **22**, grip **24**, trigger **26**, forearm **28**, port half **36**, starboard half **38**, and cavity **40**. Now, their interaction is to be understood as the substantial coupling and mating of various parts. The stock **20** comprises a butt **30**. The barrel **22** comprises a distal end **31**, proximal end **32**, opening **33**, and cover **34**. The grip **24** comprises a thumbhole **35**. The cavity comprises a power source region **42**, circuitry region **44**, barrel region **46**, and grip region **48**. The butt **30** of stock **20** is known to be the end of the anti-drone weapon **10** in that it is meant to rest against some surface including, but not limited to, a shoulder or other part of the body of the user.

[0040] The barrel **22** has distal end **31** and proximal end **32** substantially apart and opposite one another, with the extension of material between them defining the barrel **22**. Proximal to the distal end **31** is an opening **33**, defined by the absence of material surrounding the vertical plane of the anti-drone weapon. This opening further has a cover **34** which, when fully engaged, substantially covers the interior of the device, and preferably having low electromagnetic energy loss characteristics at the radio frequencies of operation. The proximal end **32** is proximal to the stock **20** and butt **30** system of the housing **12**. It is to be understood the size of the opening, and the cover respectively, are variable and dependent upon the size of the housing and barrel system.

[0041] The grip **24** of the housing **12** is generally beneath the barrel **22** and is proximal to the proximal end **32** of the barrel **22**. The grip **24** defines the thumbhole **35**. The forearm **28** is generally beneath the barrel **22** and is positioned near to the distal end **31**. The trigger **26** is situated substantially between the forearm **28** and grip **24** while also being generally beneath the barrel **22**. It is to be understood by those skilled in the art that the grip **24**, trigger **26**, and forearm **28** are substantially aligned along the vertical plane in reference to one another, which generally allows for use by either right handed individuals or left handed individuals. With reference to the horizontal plane, the grip **24**, trigger **26**, and forearm **28** are all generally within the region of the distal end **31** and proximal end **32** of the barrel **22**.

[0042] The housing **12** further is defined by two halves denoted as port half **36** and starboard half **38**. The two halves are substantially coupled by a method including, but not limited to, screws, bolts, tight-fight locks, adhesive, or other such methods that substantially couple to parts together. When both halves are coupled together, they define the cavity **40**, existing within the housing **12** of the device. The regions of the cavity include, among others, the power source region **42**, proximal and substantially within the stock **20**, the circuity region **44**, proximal and substantially between the grip **24** and stock **20**, the barrel region **46**, proximal and substantially within the barrel **22**, and the grip region, proximal and substantially within the grip **24**. It is to be understood by those skilled in the art the cavity **40** has size and dimensions dependent upon the size and thickness of the housing **12**. Further, as the cavity **40** is known to be the location in which the antenna and circuity assemblies are located, the cavity is to be suitably sized to allow all parts to be arranged within. The amount of vacant spaced defined between these assemblies is variable and subject to change in contemplated configurations of the device.

[0043] The helical antenna assembly **13**, shown best in FIG. **5**, comprises grounding plate **50**, outer helical antenna **52**, inner helical antenna **54**, and mounting assembly **56**. The outer helical antenna **52** and inner helical antenna **54** are coupled to the grounding plate which is, through fasteners coupled to the housing. Both antennas are known to be substantially radially aligned in reference to one another. That is to say, the central axis of the outer helical antenna **52** and the inner helical antenna **54** are substantially aligned with reference to one another.

[0044] The mounting assembly **56** further comprises upper mounting bracket **58**, consisting of outer helical

interface **53** and inner helical interface **55**, and lower mounting bracket **59**, and generally comprises a polymer member having polymer ties coupling or extending around the helical windings. The mounting assembly **56** has upper mounting bracket **58** which couples substantially to the outer helical antenna **52** and inner helical antenna **54** along a number of defined by known points. The outer helical interface **53** couples the upper mounting bracket **58** to the outer helical antenna **52** and the inner helical interface **55** couples the inner helical antenna **54** to the upper mounting bracket **58**. The lower mounting bracket **59** couples substantially to the outer helical antenna **52** along points that may or may not be identical to the upper mounting bracket **58**. The upper mounting bracket **58** is situated substantially above the lower mounting bracket **59** with reference to the vertical plane. The number of mounting points which the upper mounting bracket **58** interacts with the outer helical antenna **52** and inner helical antenna **54** is variable and subject to change in contemplated configurations of the device. Further, the method of coupling the mounting assembly to the helical antenna systems may include methods such as, but not limited to, cable ties and the like.

[0045] The helical antenna assembly **13** is coupled and aligned substantially to the barrel **22** of the housing **12**. This is done in such a way the central axis of the helical antennas extends through the opening **33** of the barrel **22**. The grounding plate **50** substantially couples to the proximal end **32** of the barrel **22** and with the helical antenna systems extending towards the distal end **31** of the barrel **22**. The upper mounting bracket **58** couples to the higher region of the barrel **22** and the lower mounting bracket **59** couples substantially to the lower region of the barrel **22**. It is further to be understood that the helical antenna assembly **13** is of length substantially similar or less than the length of the barrel **22** in relation to the distance between the distal end **31** and proximal end **32**.

[0046] The second antenna assembly **14**, shown best in FIGS. **4** and **6**, comprises a substrate **60**, leads **62**, director **64**, reflector **66**, and driver element **68**. In the configuration shown, the leads **62** are positioned on the substantially opposite surface as the plurality of directors **64**, reflector **66** and driver element **68**. The base **60** is the source of coupling for the second antenna assembly to the housing **12** and may be done through methods including, but not limited to, bolts, screws, adhesives, or other methods that substantially couple two parts together. The second antenna assembly **14** is coupled substantially to the starboard half **38** of the housing **12** by methods described previously within the barrel region **46** of the cavity **40**. With reference to the helical antenna assembly **13**, the second antenna assembly **14** is substantially in line with it with reference to its horizontal plane, and generally directed similarly down the barrel **22**. Further, it is to be known the length of the second antenna assembly is substantially equal to or less than the barrel **22**. In the configuration shown, the second antenna comprises a broadband quasi-yagi antenna.

[0047] The third antenna assembly **15**, as shown in FIG. **8**, comprises a flexible substrate **70**, directors **74**, and elements **78**. The third antenna is coupled to the port half of the housing **12** by methods described previously, within the barrel region **46** of the cavity **40**. In the configuration shown, the third antenna comprises a directed log-periodic antenna that is positioned so as to be of multiple components that are arranged in a non-planar configuration, and which pass between the openings in the grip (thumbhole) and the trigger. It will be understood that certain modifications are made to the configuration to allow for the components to work around the openings in the housing and to operate therewithin, while maintaining the same within the confines of the housing. In the configuration shown, the third antenna components are all separated by a predetermined distance, but follow a substantially matching curvature to that of the cavity **40** surface.

[0048] The power supply **16**, shown best in FIG. **7**, is substantially coupled to the stock **20** of the housing **12** in the power source region **42** of the cavity **40**. It is to be understood by those with skill in the art that the battery size may vary depending upon the housing size, intended use of the anti-drone weapon, length of operation, and other such factors. With respect to the exemplary figure, the power supply **16** is a rechargeable lithium ion battery and operates on supplying a 9-21V voltage range, allowing for one or more hours of continuous transmit operation or six or more hours of sensor receive operation. The length of times described may increase or decrease depending upon alterations or improvements made to the battery or device in future contemplated configurations. It will be understood that an additional battery pack or an external battery pack may be coupled to the weapon.

[0049] The processor and control circuitry **17**, shown best in FIGS. **3**, **4**, and **7**, is a multitude of electrical elements that control the operation of the device. These elements are mounted to the housing system **12** within the circuitry region **44** of the cavity **40**. The method of mounting may include, but not be limited to, bolts, screws, soldering, or other methods of securing electrical devices. With regards to the control panel assembly **18**, shown best in FIGS. **2**, **3**, **6**, and **7**, the assembly comprises user actuatable elements **80** and indicators **82**. The positioning, number, and size of these elements are variable and subject to change in contemplated configurations of the device. It is to be understood by those with skill in the art that the user actuatable elements **80** are input devices that affect the anti-drone weapon **10** in some meaningful way with respect to what is available within the context of the elements. These elements may include, but are not limited to, powering the system, voltage regulation, operating frequency, and antenna assembly selection. The indicators **82** are output displays that may include, but are not limited, digital readings, lights, digital scales, or other such methods of indicating the system function. The control panel assembly **18** further interacts with the processor and control circuitry **17** in such a way that it provides both input to and receives output from the electrical elements described previously. It is contemplated that a software-defined waveform is utilized that is generated digitally, modified with analog circuitry, transformed to radio frequency through a radio frequency synthesis circuit, and further amplified and directed to the antenna. Of course, other waveforms are contemplated for amplification and direction to the antenna.

[0050] Described herein are the contemplated specifications for the anti-drone weapon **10**. These specifications are dependent upon the materials used, available power supply, electrical system chosen, and other such parameters. These metrics may be altered in future configurations of the device such that the device can be used in situations either broader or more specified than already provided.

[0051] The anti-drone weapon in the configuration shown, generally weighs approximately 3.6 kg (preferably less than

6 kg) when fully assembled and can be operable by either left or right-handed users. It has operation temperatures between −20 to 40° C. with a preferred storage temperature range of −40 to 85° C. The housing seals the inner parts, including the antenna assemblies, power supply, processor and control circuitry from the environment. Further, the housing is ruggedized for shock and vibration abatement, such that sudden accelerations of the device will not result in substantial harm to the equipment existing within the cavity. Of course, these are merely exemplary, and other configurations are contemplated.

[0052] The antenna assemblies described previously operate in generally different frequency ranges, powered by the power supply. These frequency ranges are understood to be alterable and may change under a variety of circumstances including user input, power supply, range from target, and other such means. The helical antennas generally operate on ranges that include GNSS (including GPS, GLONASS, Galileo, and BeiDou) L1, GNSS L2, 1250 to 1290 MHz, 2.4 to 2.5 GHz, and 5.6 to 6 GHz frequencies. The second antenna generally operates at 870 to 928 MHz frequencies. The third antenna generally operates between 420 to 460 MHz frequencies. The weapon has an operational range of several hundred meters up to, preferably, 1,000 meters to address the majority of threats at a tactically advantageous standoff distance. Further, and preferably, the weapon is able to recognize and sense drones and pilot ground station equipment and activity at a range up to and including 3.2 kilometers in distance. Again, these comprise merely illustrative configurations, and it is contemplated that variations may be provided, including differently configured antenna and the like. It is contemplated that the frequency range of the antenna is between 400 MHz and 6 GHz and beyond. It will be understood that various configurations allow for such frequency range operation.

[0053] The foregoing description merely explains and illustrates the disclosure and the disclosure is not limited thereto except insofar as the appended claims are so limited, as those skilled in the art who have the disclosure before them will be able to make modifications without departing from the scope of the disclosure.

What is claimed is:

1. An anti-drone weapon comprising:

a housing;

at least one antenna positioned within the housing, the at least one antenna capable of operating at a frequency at least between 400 MHz and 6 GHz.

2. The anti-drone weapon of claim **1** further comprising:

a power supply, processor and control circuitry and a control panel, within the housing.

3. The anti-drone weapon of claim **1** wherein the at least one antenna comprises a double helical antenna, a quasi-yagi antenna, and a directed log-periodic antenna.

4. The anti-drone weapon of claim **1** wherein the housing further includes a stock and a barrel extending therefrom, the barrel including a proximal end and a distal end.

5. The anti-drone weapon of claim **4** wherein a power supply, processor and control circuitry is maintained in one of the stock and the barrel.

6. The anti-drone weapon of claim **4** wherein the barrel defines a cavity, having a double helical antenna positioned with a base at the proximal end, and extending toward the distal end.

7. The anti-drone weapon of claim **6** wherein the double helical antenna is coupled to the barrel between the proximal and distal end through at least one of an upper mounting bracket and a lower mounting bracket.

8. The anti-drone weapon of claim **7** wherein the upper mounting bracket and the lower mounting bracket comprise a polymer, which is releasably coupled to at least one helix of the double helical antenna.

9. The anti-drone weapon of claim **6** further comprising a second antenna assembly positioned to a first side of the double helical antenna and extending between the proximal and the distal end.

10. The anti-drone weapon of claim **9** wherein the second antenna comprises a quasi-yagi antenna.

11. The anti-drone weapon of claim **10** wherein the second antenna is substantially planar.

12. The anti-drone weapon of claim **9** further comprising a third antenna assembly positioned to a second side of the double helical antenna.

13. The anti-drone weapon of claim **12** wherein the third antenna comprises a directed log-periodic antenna.

14. The anti-drone weapon of claim **13** wherein the third antenna is in a non-planar configuration.

15. The anti-drone weapon of claim **12** wherein the housing further includes a trigger and a thumbhole for the grip, wherein a portion of the third antenna extends between the trigger and the thumbhole for the grip.

16. The anti-drone weapon of claim **12** wherein the first antenna operate on ranges that include GNSS (including GPS, GLONASS, Galileo, and BeiDou) L1, GNSS L2, 1250 to 1290 MHz, 2.4 to 2.5 GHz, and 5.6 to 6 GHz frequencies, the second antenna generally operates at 870 to 928 MHz frequencies and the third antenna generally operates between 420 to 460 MHz frequencies.

17. The anti-drone weapon of claim **1** wherein the anti-drone weapon weighs approximately 6 kilograms or less.

18. The anti-drone weapon of claim **1** having a range of approximately 1000 meters.

19. The anti-drone weapon of claim **1** wherein the housing is formed from a port case half and a starboard case half.

* * * * *